United States Patent [19]

Hufstader

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[54] **ELECTRIC MOTOR-DRIVEN IMPELLER-TYPE AIR PUMP**

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[73] Assignee: **General Motors Corporation**, Detroit, Mich.

[21] Appl. No.: **280,044**

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[51] **Int. Cl.**[4] **F04D 29/28**

[52] **U.S. Cl.** **417/370**; 417/423.15; 417/423.14; 415/204; 415/169.1

[58] **Field of Search** ..... 417/370, 424.1, 357, 417/423.14, 423.9, 423.15, 423.11, 542; 60/307, 284; 415/219 C

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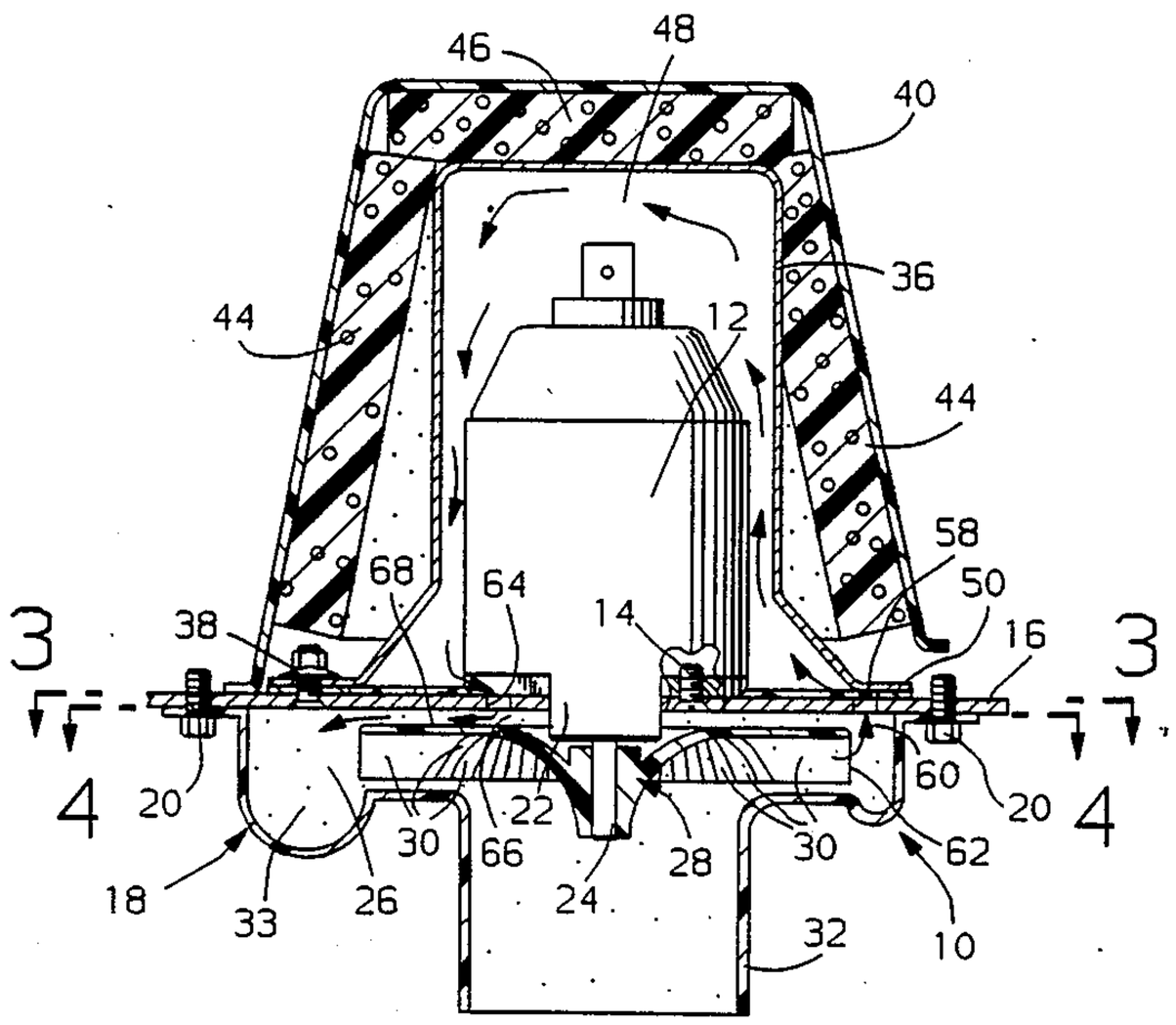
Assistant Examiner—David W. Scheuermann
Attorney, Agent, or Firm—C. K. Veenstra

[57] **ABSTRACT**

A high speed electric motor drives an impeller to centrifugally induce air flow to an engine exhaust system. The motor is sealed within a noise attenuating cover, and the impeller induces a portion of the air flow to recirculate through the sealed motor chamber to cool the motor. A noise attenuating duct is mounted on the pump inlet. The duct includes an elongated neck of rectangular cross-section extending at an angle from a tubular body, the remote end of said neck being tapered, each side of the neck having a series of parallel inlet louvers, and the body having an internal foam liner.

3 Claims, 4 Drawing Sheets



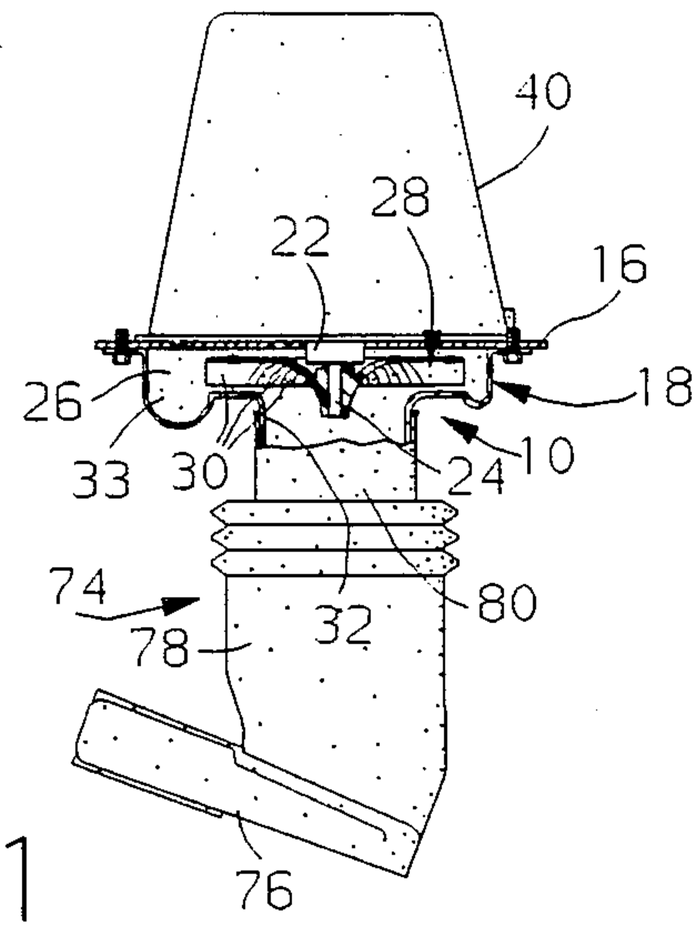

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FIG. 1

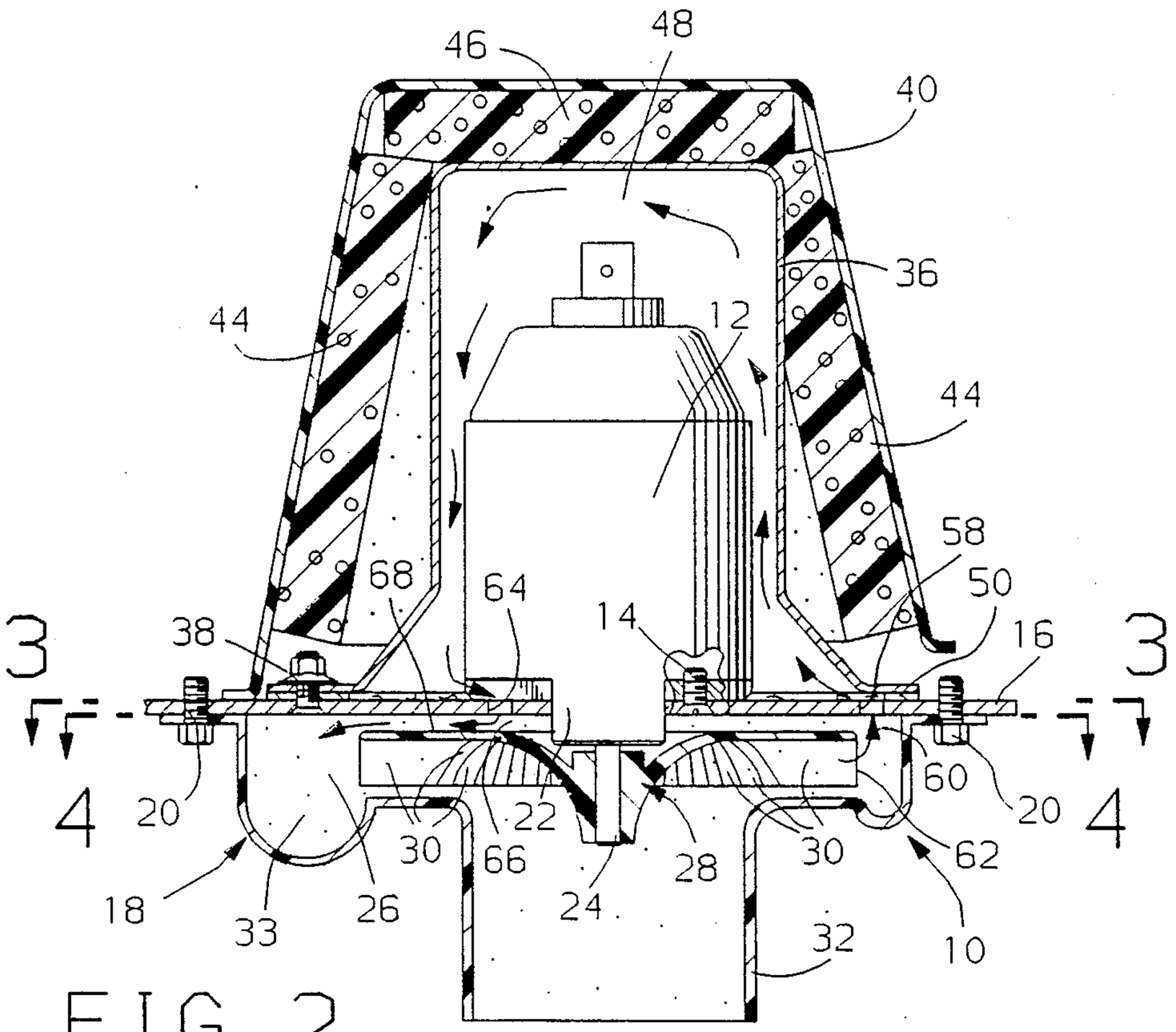
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FIG. 2

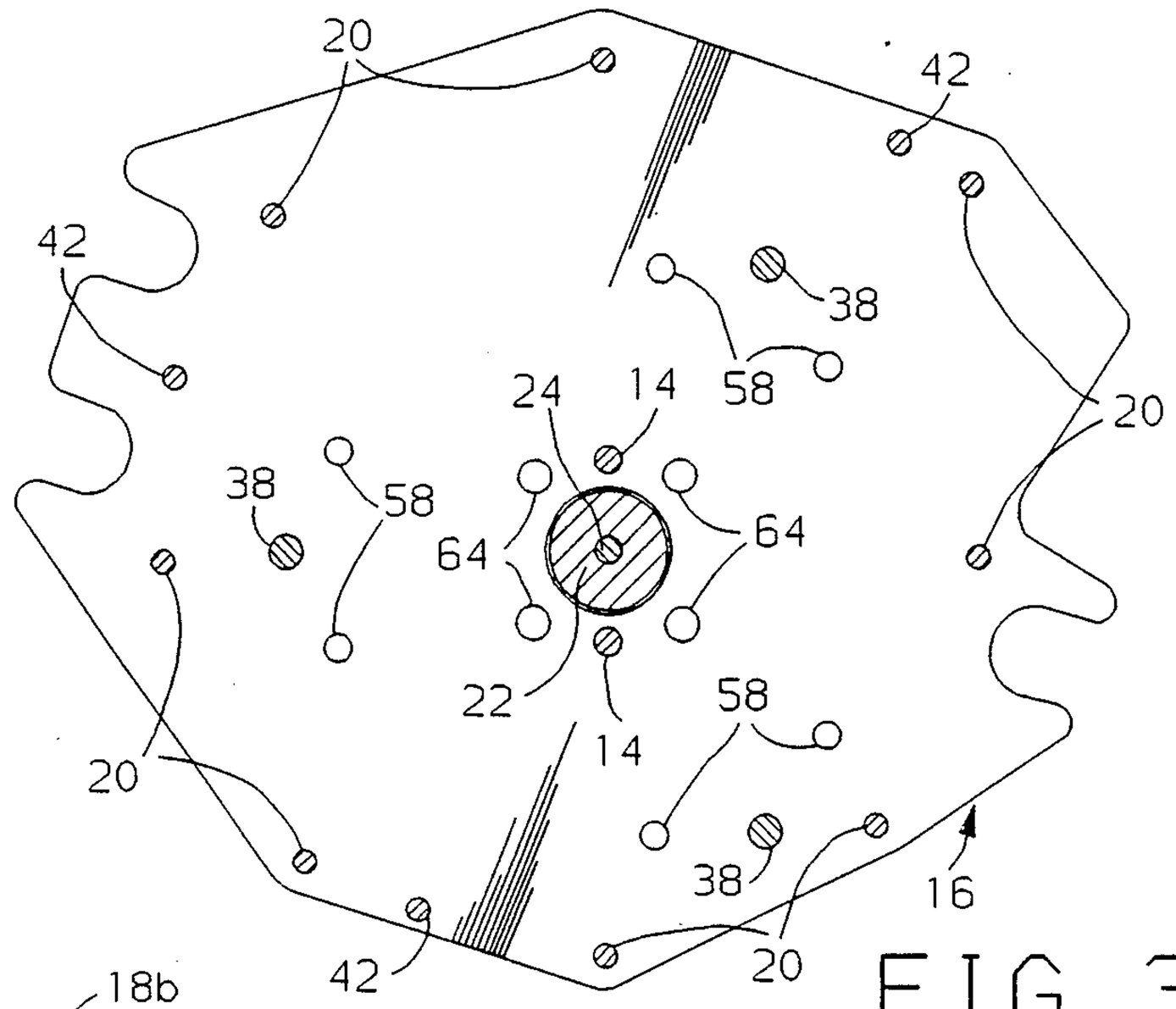

FIG. 3

FIG. 4A

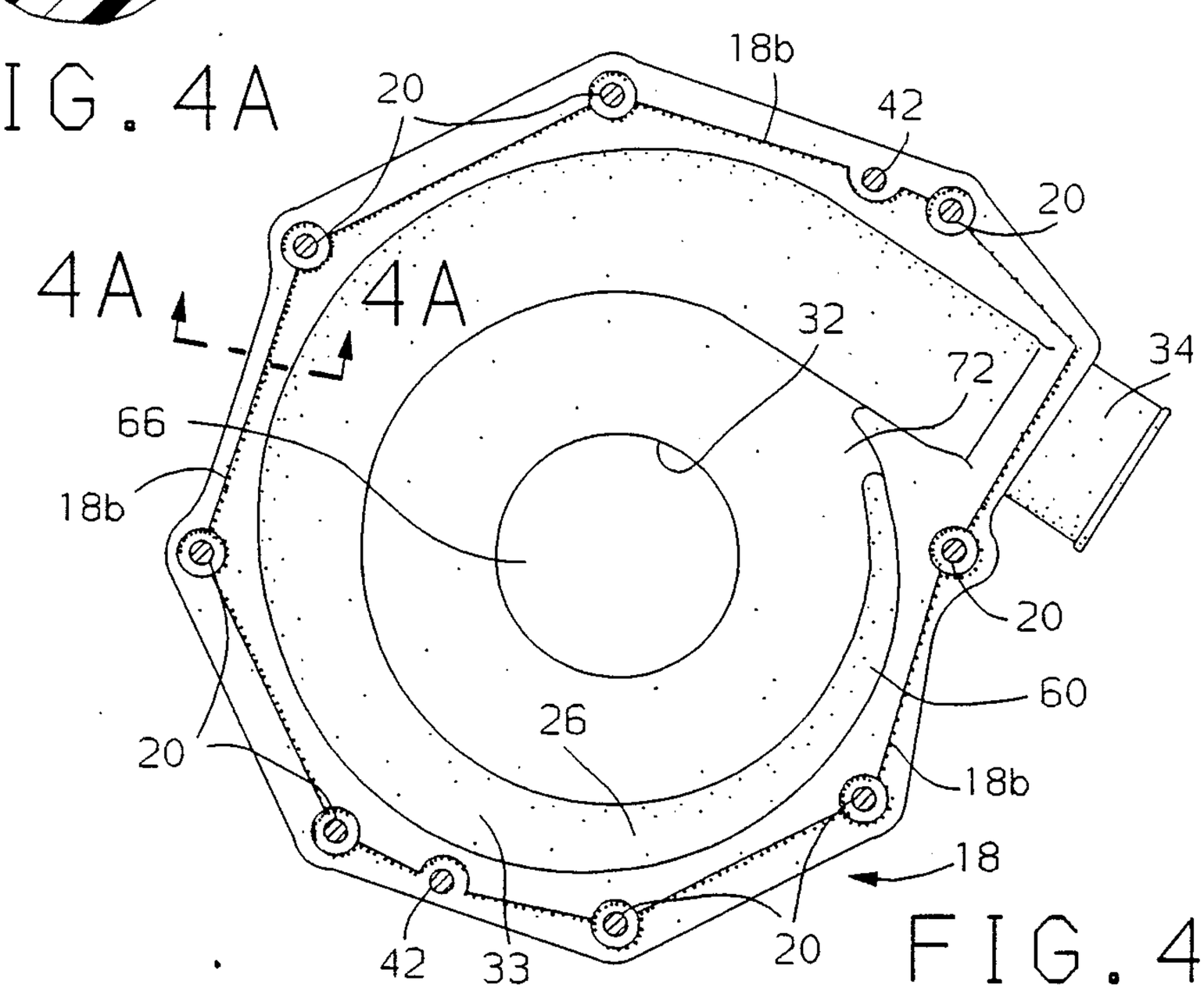

FIG. 4

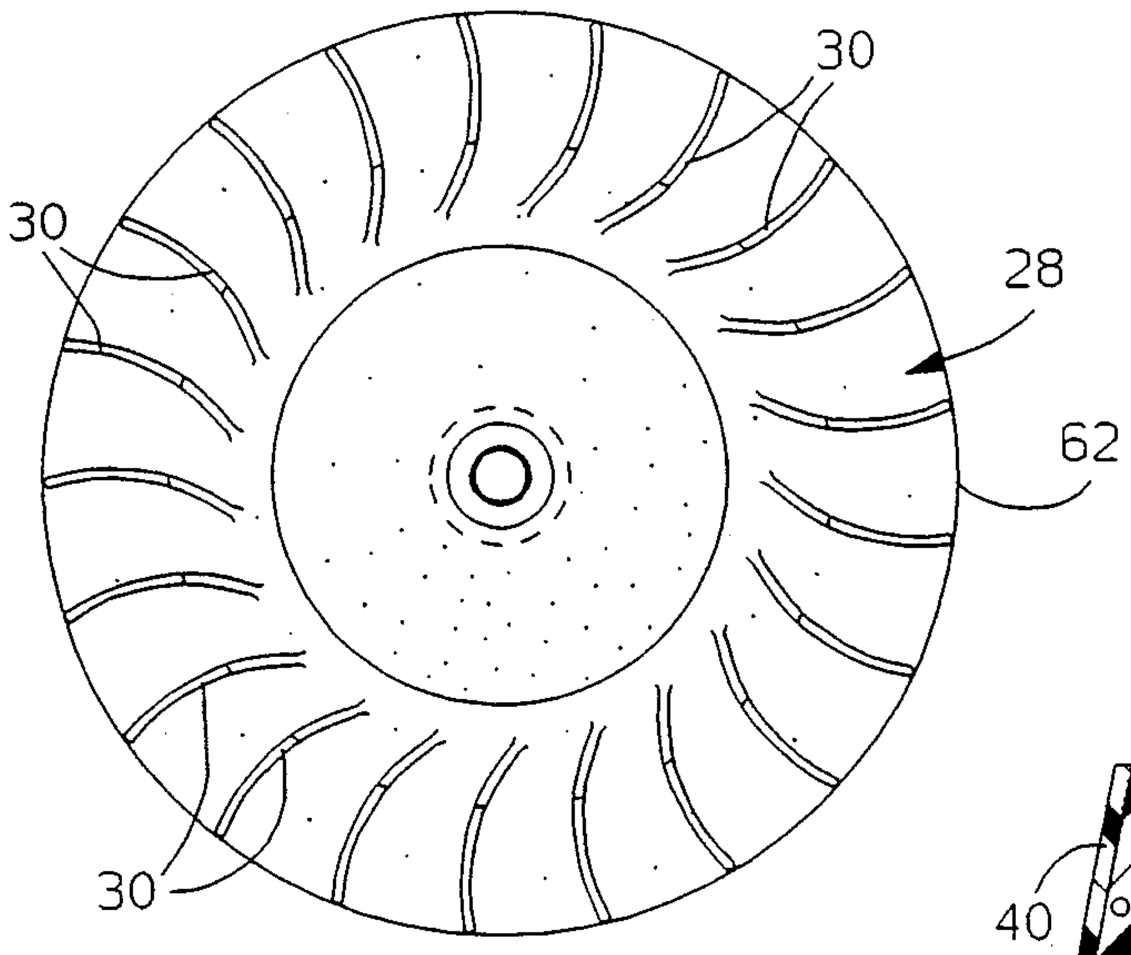

FIG.5

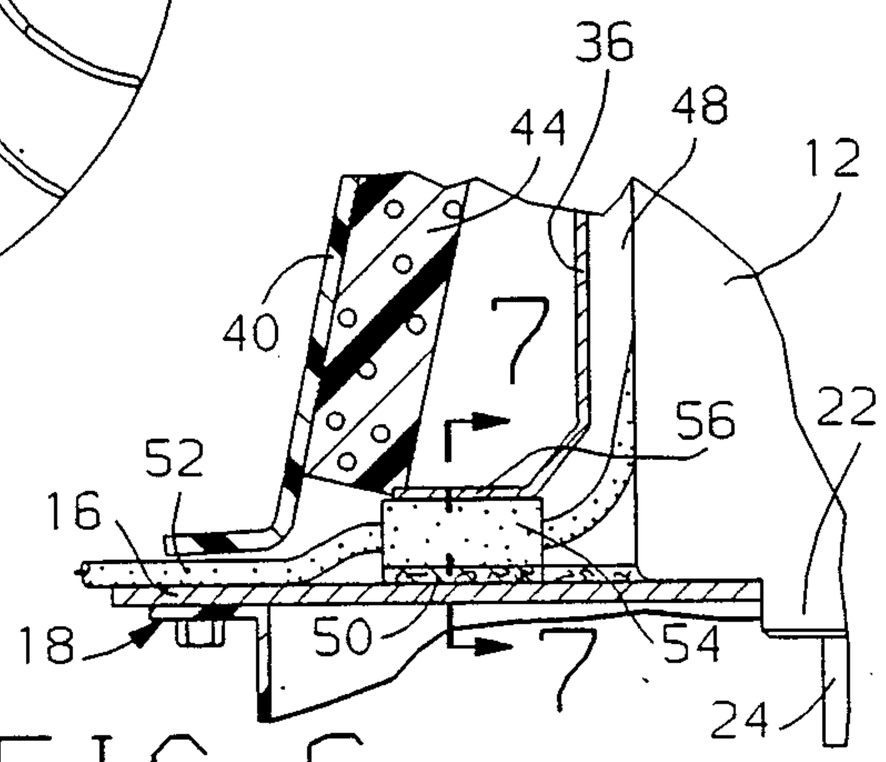

FIG.6

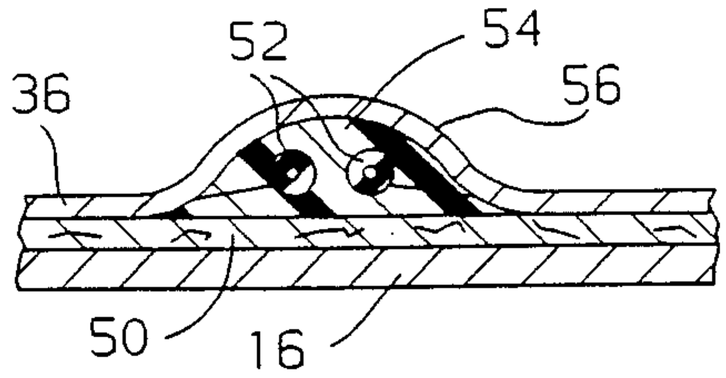

FIG.7

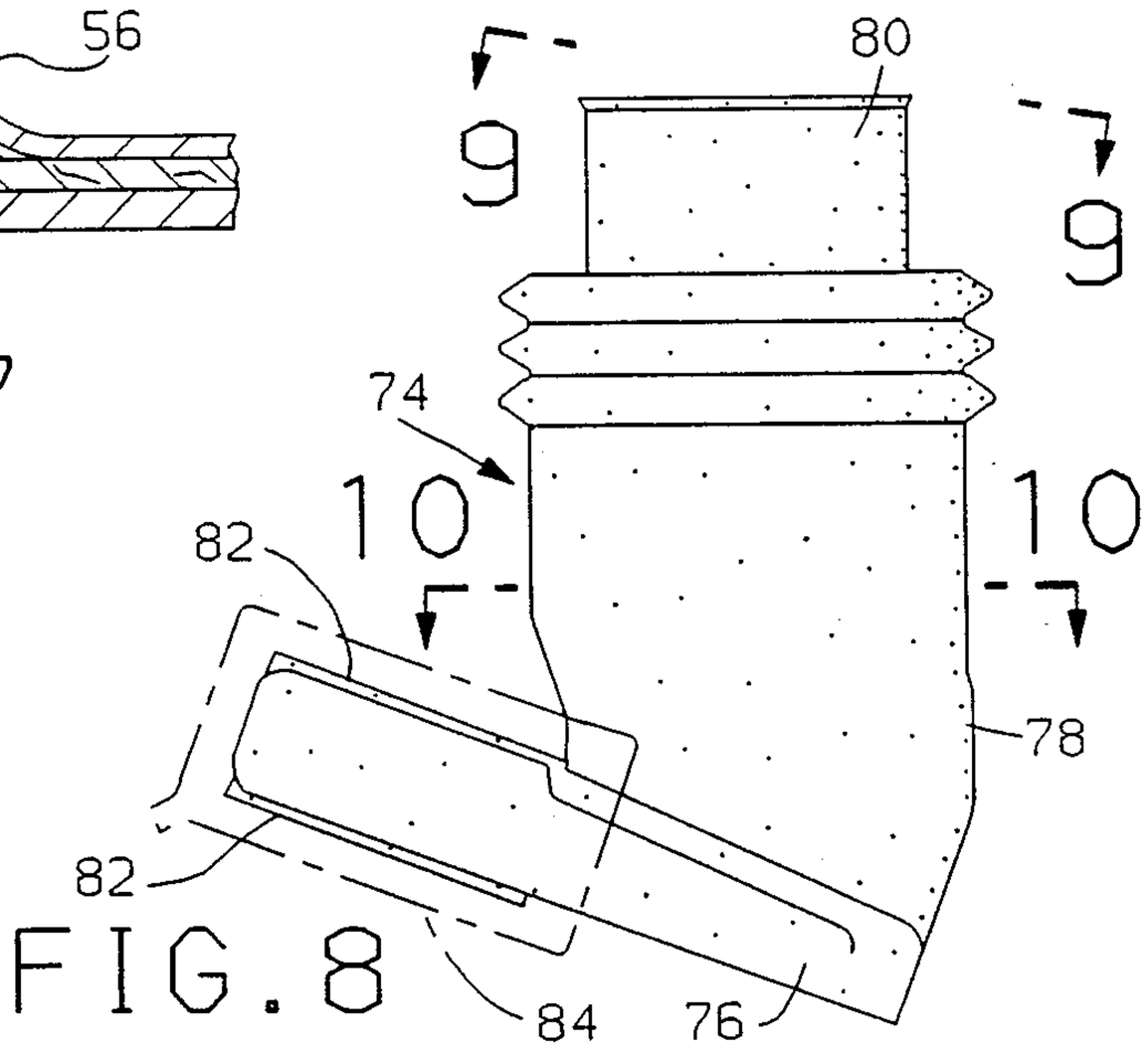

FIG.8

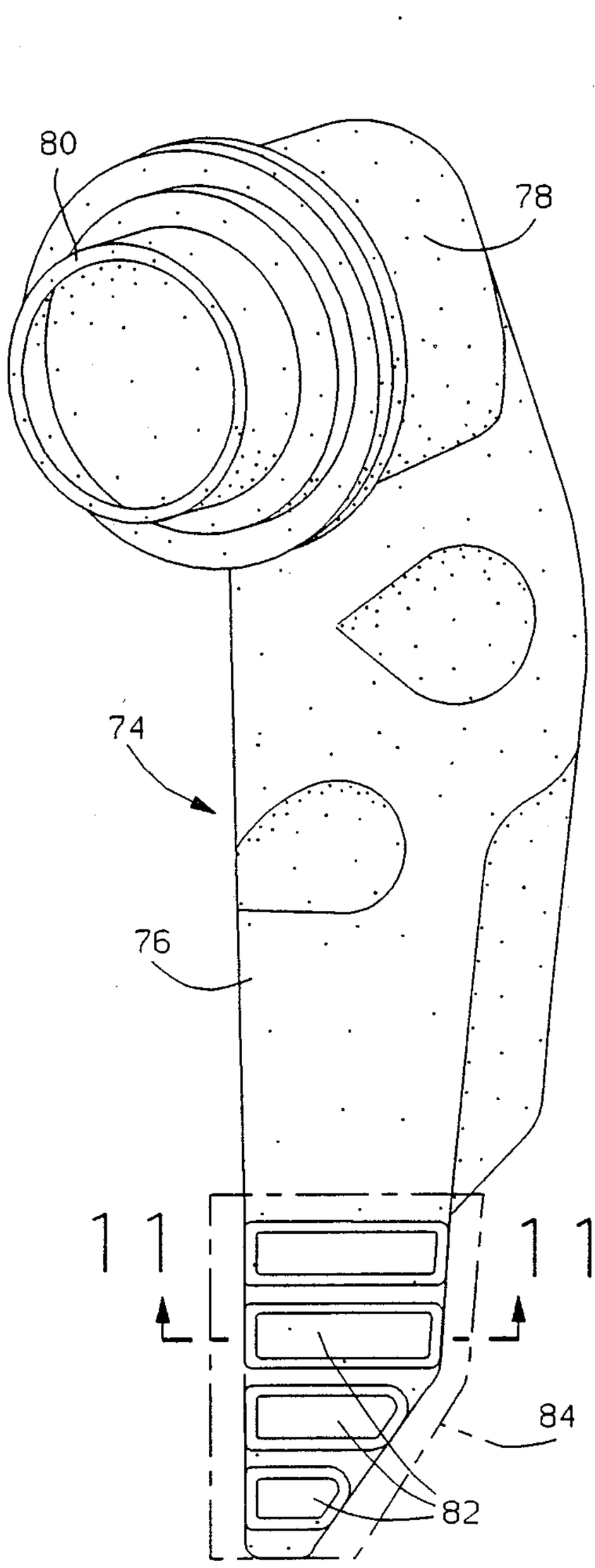

FIG. 9

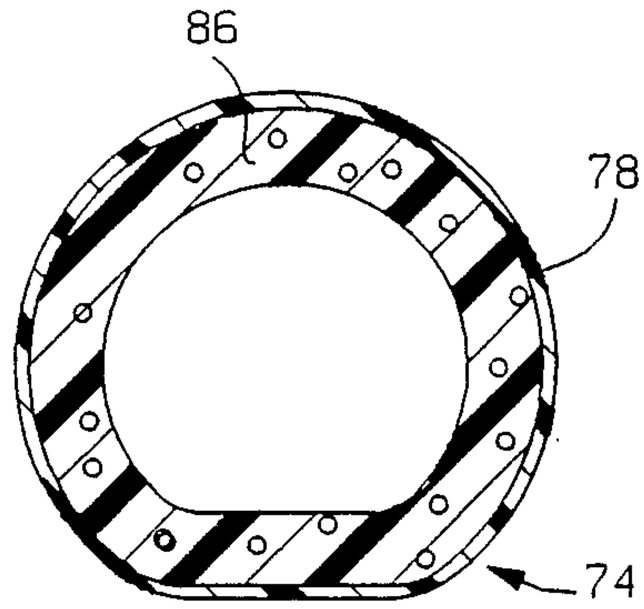

FIG. 10

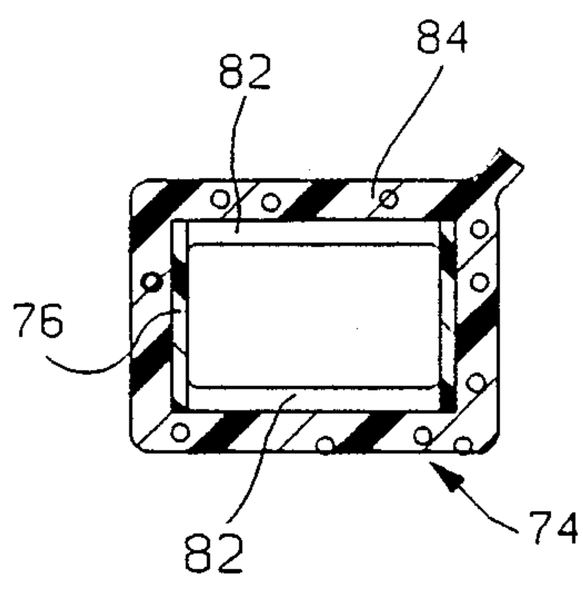

FIG. 11

ELECTRIC MOTOR-DRIVEN IMPELLER-TYPE AIR PUMP

TECHNICAL FIELD

This invention provides an electrically operated air pump suitable for supplying air to the exhaust system of an automotive engine.

BACKGROUND

Automotive engines often have an air pump that supplies air to the engine exhaust system. The air supports combustion of hydrocarbons and carbon monoxide in the exhaust system to minimize emission of those compounds into the atmosphere.

In the past, such air pumps generally have had a mechanical drive from the engine and accordingly consumed power from the engine during all operating modes. In many applications, however, air is required to support combustion in the exhaust system only during the initial period of engine warm-up. Thus in those applications, the air pump has undesirably consumed engine power after the initial period of engine warm-up.

SUMMARY OF THE INVENTION

This invention provides an electrically operated air pump that may be operated to supply air to an engine exhaust system only during those periods when air is required to support combustion in the engine exhaust system. This air pump accordingly consumes power only when necessary.

In an air pump employing this invention, a high speed electric motor drives impeller in a housing to induce air flow. The air pump includes provision for attenuating air pump operating noise, and also includes provision for recirculating a portion of the air flow around the motor to prevent overheating.

The details as well as other features and advantages of a preferred embodiment of this air pump are set forth in the remainder of the specification and are shown in the accompanying drawings.

SUMMARY OF THE DRAWINGS

FIG. **1** is a view of a preferred embodiment of the air pump, including its inlet duct, a portion of the pump being broken away to show the impeller.

FIG. **2** is an enlarged axial sectional view of the FIG. **1** air pump, without its inlet duct, showing the structure for attenuating electric motor operating noise, and further showing a portion of the flow path for recirculating a portion of the air flow around the electric motor.

FIG. **3** is a sectional view, taken along line **3—3** of FIG. **1**, showing the inlet and outlet apertures that recirculate a portion of the air flow around the electric motor.

FIG. **4** is a view, indicated generally by line **4—4** of FIG. **1**, of the housing removed from the air pump.

FIG. **4A** is a section through the rim of the FIG. **4** housing, showing a sealing bead.

FIG. **5** is a view of the impeller removed from the air pump.

FIG. **6** is another, partial, axial sectional view of the air pump, showing entry of the electric motor power leads to the air pump.

FIG. **7** is a sectional view, taken along line **7—7** of FIG. **6**, showing the grommet that provides a seal around the power leads.

FIG. **8** is an enlarged elevation view of the inlet duct of FIG. **1**, showing the duct removed from the remainder of the air pump.

FIG. **9** is an end view, indicated by line **9—9** of FIG. **8**, of the inlet duct.

FIG. **10** is a sectional view, taken along line **10—10** of FIG. **8**, showing noise attenuating material inside the duct.

FIG. **11** is a sectional view, taken along line **11—11** of FIG. **9**, showing a filter around the inlet louvers of the duct.

THE PREFERRED EMBODIMENT

Referring first to FIGS. **1** through **7** of the drawings, an air pump **10** has an electric motor **12** secured by fasteners **14** to one side of a mounting plate **16**, and a housing **18** secured by fasteners **20** to the opposite side of plate **16**. The nose **22** of motor **12** nests in plate **16** and has a shaft **24** that extends into the working chamber **26** between plate **16** and housing **18**. Shaft **24** supports and drives an impeller **28** in chamber **26**. Impeller **28** has a plurality of blades **30** that are swept around chamber **26** to centrifugally induce air flow from a central axially oriented inlet fitting **32** into a peripheral scrolled region **33** that leads to an outlet fitting **34**.

The operating characteristics of air pump **10** are exemplified by the following test results:

pressure	flow	current	speed
20.8	0	14.2	18462
19.7	7.1	14.6	18328
18.6	14.1	15.0	18058
18.0	17.3	15.1	17961
17.1	22.3	15.6	17784
15.6	29.9	16.4	17589
14.5	33.6	16.8	17411
11.5	41.5	17.8	17112
8.1	49.7	19.6	16820
4.3	56.8	21.2	16552
0	63.3	22.6	16281

Power was supplied at 13.5 volts DC, the pressure was measured as the difference between inlet fitting **32** and outlet fitting **34** in inches of water, the flow was measured in cubic feet per minute, the current was measured in amperes, and the speed was measured in revolutions per minute (rpm).

To attenuate the noise generated by a motor operating at those speeds, motor **12** is surrounded by an aluminum cover **36** secured to plate **16** by fasteners **38**, a polypropylene shell **40** secured to plate **16** by fasteners **42** (FIG. **3**), and foam pads **44** and **46** sandwiched between cover **36** and shell **40**.

The chamber **48** surrounding motor **12** is sealed by a gasket **50** sandwiched between cover **36** and plate **16**, and as shown in FIGS. **6** and **7**, the power leads **52** for motor **12** enter chamber **48** through a grommet **54** received in a dimple **56** formed in the rim of cover **36**.

Plate **16** has a series of six peripherally spaced apertures **58** opening to the motor chamber **48** from the high pressure zone **60** of working chamber **26**, near the rim **62** of impeller **28**. Plate **16** also has a series of four peripherally spaced apertures **64** opening from the motor chamber **48** to a central low pressure zone **66** of working chamber **26**, near the nose **22** of motor **12**. The back **68** of impeller **28** is spaced about 2 or 3 millimeters from plate **16**. During operation, impeller **28** induces a portion of the air flow to recirculate from high pressure

zone **60** through apertures **58**, sealed motor chamber **48**, and apertures **64** into low pressure zone **66**. The recirculating air flow cools motor **12**.

Power is supplied to motor **12** only when operation of air pump **10** is required. When used to supply air to the exhaust system of an automotive engine, outlet fitting **34** is connected through the conduits and control valves desired for the particular application, and an appropriate control supplies power to motor **12** only when air is required to support combustion in the engine exhaust system.

Within working chamber **26**, the small end of scrolled region **33** is separated from the large end of scrolled region **33** by a land **72**. Land **72** is tapered axially to avoid abrupt pressure changes as the impeller blades **30** are swept past land **72**; tapered land **72** thereby minimizes generation of noise within the air pump.

If desired, the rim of housing **18** may include a bead **18***b* that seals directly against plate **16**. Bead **18***b* obviates the need for a gasket between housing **18** and plate **16** while allowing very slight clearance between impeller **28** and housing **18**.

Referring now to FIGS. **8** through **11**, an inlet duct **74** is provided to attenuate noise emitted from air pump inlet fitting **32**. Duct **74** is formed of polypropylene and has an elongated neck **76**, of generally rectangular cross-section, extending at an angle from a short generally tubular body **78**. Body **78** extends to a fitting **80** adapted to be secured about pump inlet fitting **32**. The upper or remote end of neck **76** is tapered, and at least two opposing sides have a series of parallel inlet louvers **82**. Louvers **82** are surrounded by a filter **84** formed of open cell polyurethane foam. Body **78** also has an internal liner **86** formed of polyurethane acoustical foam.

I claim:

1. An air pump having an electric motor secured to one side of a mounting plate, and a housing secured to the opposite side of said plate, said motor having a shaft that extends into a working chamber defined between said plate and said housing, said shaft supporting and driving an impeller in said chamber to centrifugally induce air flow through said chamber, wherein a cover is secured to said plate and encloses said motor in a sealed chamber defined between said cover and said plate, said plate has a series of peripherally spaced apertures opening to said sealed chamber from the high pressure zone of said working chamber near the outer rim of said impeller, said plate also has a series of peripherally spaced apertures opening from said sealed chamber to a central low pressure zone of said working chamber between said plate and the back of said impeller, and said impeller induces a portion of the air flow to recirculate from said high pressure zone through said sealed chamber, about said motor and into said low pressure zone to cool said motor.

2. An air pump having an electric motor secured to one side of a mounting plate, and a housing secured to the opposite side of said plate, said motor having a shaft that extends into a working chamber defined between said plate and said housing, said shaft supporting and driving an impeller in said chamber to centrifugally induce air flow through said chamber, wherein a cover surrounds said motor, foam pads surround said cover, and a shell surrounds said foam pads, said cover, foam pads and shell being effective to attenuate the noise generated by said motor, and wherein said cover is secured to said plate and encloses said motor in a sealed chamber defined between said cover and said plate, said plate has a series of peripherally spaced apertures opening to said sealed chamber from the high pressure zone of said working chamber near the rim of said impeller, said plate also has a series of peripherally spaced apertures opening from said sealed chamber to a central low pressure zone of said working chamber between said plate and the back of said impeller, and said impeller induces a portion of the air flow to recirculate from said high pressure zone through said sealed chamber, about said motor and into said low pressure zone to cool said motor.

3. An air pump for delivering air to an engine exhaust system, said air pump having an electric motor secured to one side of a mounting plate and a housing secured to the opposite side of said plate, said motor having a shaft that extends into the working chamber defined between said plate and said housing, said shaft supporting and driving an impeller in said chamber to centrifugally induce air flow from a central axially oriented inlet fitting to a peripheral scrolled region that leads to an outlet fitting, wherein an inlet noise attenuating duct has a mounting fitting secured to said inlet fitting, said duct having an elongated neck of generally rectangular cross-section extending at an angle from a generally tubular body, said body extending to said mounting fitting, the remote end of said neck being tapered and opposing sides of said neck having a series of inlet louvers, and said body having an internal foam liner.

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